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THE FOUNDRYMEN'S ASSOCIATIONS.

A paper by Eliot A. Kebler, of Pittsburg, on "Pipe Founding" was read, as follows:

PIPE FOUNDING.

By ELIOT A. KEBLER.

In an interesting article by Mr. Jesse Garrett it is stated that cast flange pipe were used on a pump erected under the arches of London Bridge as early as 1582, and that cast iron pipe were used as water conduits in France in 1682; the way these were made has not, however, come down to us.

The first pipe were cast in this country before 1830, at Weymouth, New Jersey, for the 16-inch pumping main of the Philadelphia water works.

In that early day the blast furnaces, being hardly larger than the cupolas now in use, the molds were rammed up in the casting house and were poured direct from the furnace.

Makers of these pipe claimed to know by the appearance of the "bloom," when iron suitable for pipe was tapped, and would divert such iron from the ordinary pig bed to the pipe molds as run was made. This practice could not be relied upon to give a uniform quality of iron, and the remelting method was adopted.

Early methods are sometimes revived, and some thirty years later iron direct from the blast furnace was again used, but the results were not satisfactory.

Until about 1851 all pipe were cast horizontally, or on an

angle of about 10 degrees, the mold being rammed up in green sand in a two-part flask. The core was usually made by pressing green sand on a hollow bar which was revolved on its axis, a core board being used to bring it to the proper size.

An article by Mr. Ed. Brantlet, an employee of the Brooklyn water works, was published in 1861 in the transactions of the Franklin Institute.

At the two works where Mr. Brantlet inspected, the smaller pipe was still cast on the side, and he discussed quite fully the objections to this mode of casting, either with a green sand core or with one similar to those now in use.

As late as 1873 some water pipe were still cast on the side in Pittsburg, and as a molder and helper made the molds and cores for thirteen 4-inch pipe 9 feet long, each day, a large output was certainly obtained by this method which seems so antiquated to-day.

In the English practice the pipe were cast some eight inches longer than the finished pipe, this excess being cut off in a lathe, thus removing any dirt that might have lodged in the top of the pipe, and also leaving the bead end tapering to center the pipe in when laid, there being a corresponding taper at the bottom of the socket.

In the American practice no machinery is required, a bead being cast on the spigot end of the pipe, and a wedge-shaped recess on the inside of the socket, this last keeping the joint tighter than when the half circle recess is used as in the English practice.

A visit to a modern foundry making water and gas pipe is of much interest to those engaged in the casting of metals, as the large tonnage and quick handling of the tools cannot but appeal to them.

PIT. The pit, which is usually lined with heavy stones, is circular, having a rectangular offset from one side to facilitate ramming, and having at the end a large rectangular oven for drying the molds.

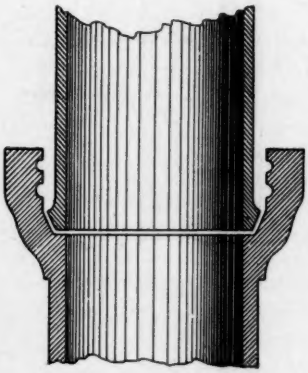
The center of the pit which is built up to the level of the

foundry floor, usually supports two cranes, one used principally by the casting gang, the other assisting the rammers.

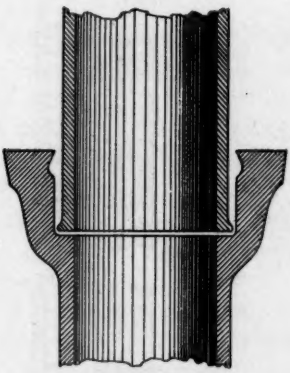
FLASKS. The flasks are of iron, hinged vertically, and are single for large pipe, but for smaller ones, double, triple, and sometimes quadruple flasks are used.

RAMMING. The empty flask is placed vertically on the ramming stool, where it is rammed up by hand, a straight pattern being used for the body, the socket being formed by a separate pattern.

In some shops the mold is formed mechanically by a taper pattern or a machine which presses the sand against the sides of the flask.



ENGLISH PRACTICE.



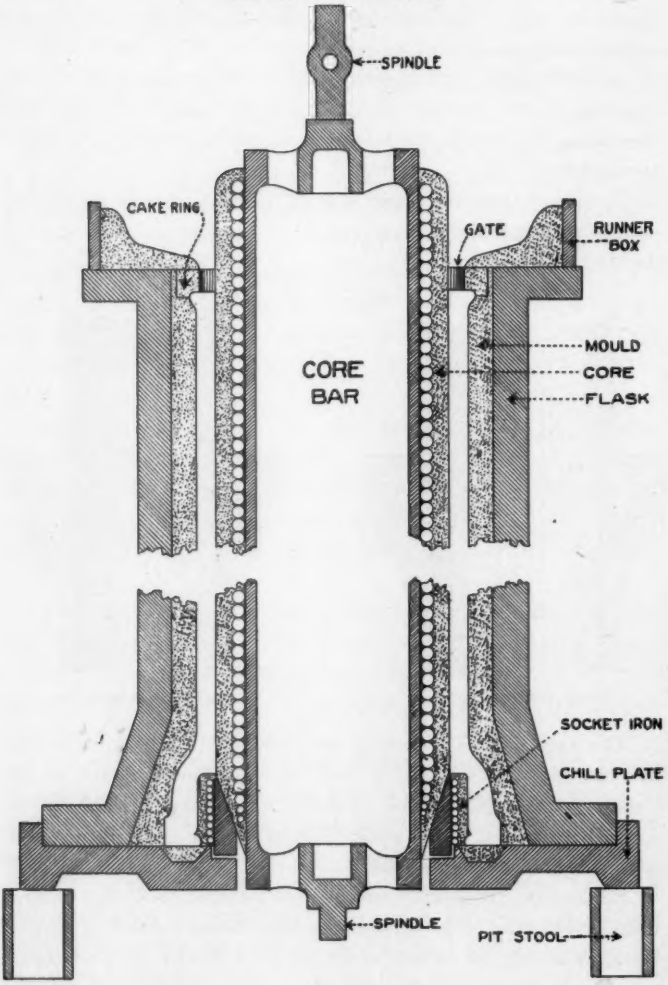
AMERICAN PRACTICE.

The sand used is ordinarily cut over night in the foundry, but the large quantity used as well as the limited space in the foundry, make its removal to another building desirable where it can be screened, mixed and tempered, then being returned as fast as desired by a conveyor.

Small pipe are usually molded socket up, the socket pattern slipping over the body pattern, the bead being formed in various ways, by a ring set on the ramming stool, a clay cake set into a recess in the bottom of the mold by a rubber bead ring, etc.

Pipe over 10 inches in diameter are usually molded socket

SECTIONAL VIEW PIPE MOULDED SOCKET DOWN.



down, care being taken that the socket cores are well made, as the iron falling twelve feet directly on them, subjects them to such rough usage that formerly it was considered necessary to bottom pour the pipe through a runner extending to the bottom of the mold.

After ramming, the flasks are lifted on to casting plates (usually called chill plates), which are clamped to flanges on the bottom of the flasks, and a bucket of blacking is poured through the molds to prevent cutting.

In many shops the pipe is rammed up direct on the casting plate.

DRYING. The molds are now placed on top of the oven, and are dried from the inside, as they act like chimneys for the oven, the heat passing up through them.

CORE MAKING. While the molds are being rammed up, a gang is busy making up the cores, starting with a steel or cast pipe, well drilled for venting as a core bar.

These bars are turned by power or hand and a rope spun by an ingenious machine from straw or marsh hay is closely wound from end to end of the bar.

A visitor, seeing nearly half a mile of hay rope being used for each pipe five feet in diameter, thinks he ought to take an hour off to show the benighted foundrymen some method to avoid this expense, not appreciating that nearly everyone connected with the industry, has been laboring for years to do away with the use of the rope. While many core compounds have been tried, and numberless collapsing bars designed to allow the bars to be withdrawn after casting, none, I believe, so perfectly meets the conditions of work here, that the use of hay has been permanently done away with in any shop in the United States.

The hay on the bar is held in place by a strong first coat of clay on which, when dried, a second coat is struck on, a core board being used to bring the core to its proper size; this board also tapers the cores at the bottom, so that they will center in the casting plate when placed in the mold.

After blacking, the cores are placed in the core ovens and dried.

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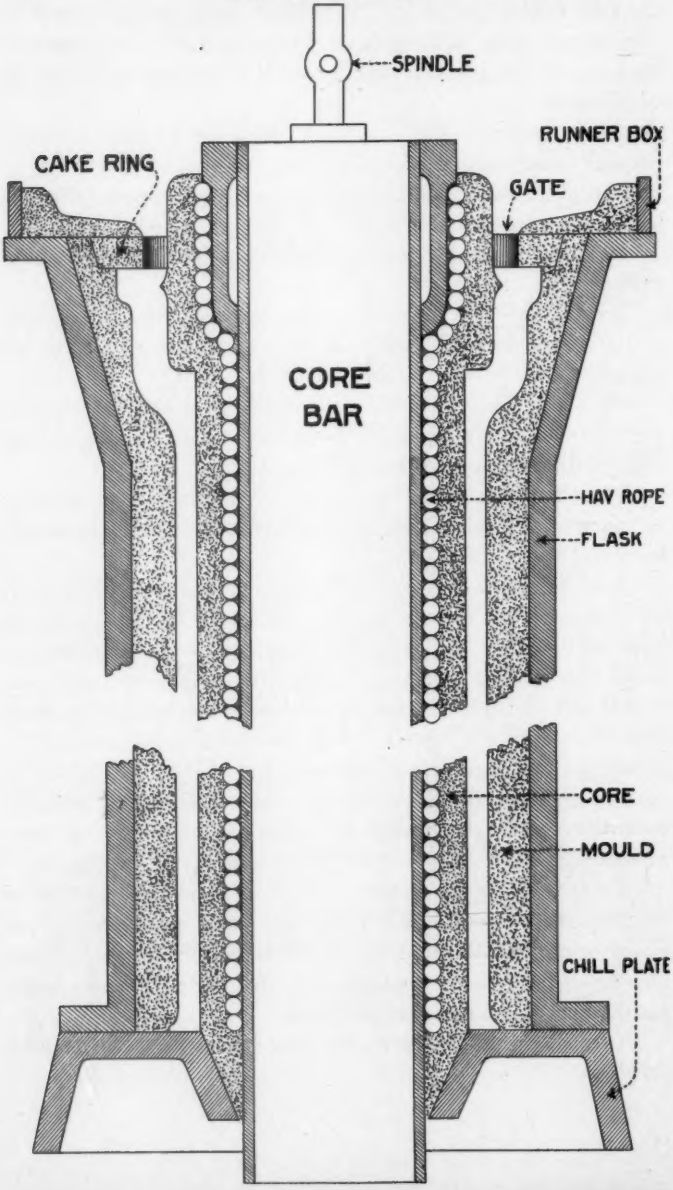
SECTIONAL VIEW PIPE MOULDED SOCKET UP.



In small pipe, the inside of the socket is often struck upon the body core, although a socket core made separately, to slip over a straight body core is preferred by many, as a constant depth of socket is thus assured.

For large pipe the sockets are made up separately on an iron socket ring which fits in a recess in the casting plate, the body core centering in this ring.

CASTING. In the morning the dried molds are set around the casting pit, the dried cores placed in them, and dry clay cake rings with gates in them are slipped over the cores to form the top of the pipe and center the cores at the top, and a good sized runner is formed to collect any dirt.

In early days but little attention was paid to the kinds of iron used, but now great care is taken in making the mixture and running the cupolas. Some of the works employ chemists who take entire charge of the mixing and melting, they being held accountable for losses originating from these sources.

Owing to its fluidity and low shrinkage, southern iron usually makes up all or part of the mixture used for casting pipe.

The iron melted in cupolas is tapped into ladles which, if in reach of the pit crane is picked up by it and the molds are poured. If the cupolas are further away the ladles resting on trucks are pulled within reach of the crane by a small locomotive.

Some years ago a mule, which hauled the ladles of iron, had a way every month or two of slipping into the pit, but the foreman effectually cured him of this the next time he fell in by hoisting him up to the roof a number of times, and while high above the floor, swinging the crane very rapidly.

STRIPPING. After casting, the core bars are withdrawn, the flasks are hoisted from the pit, chill plates and clamps knocked off, and the pipe dropped out on a skid, the flasks being returned to the ramming pit.

CLEANING. The pipe now roll through the cleaning shed where the cores are cut out with steel rods, fins, etc., are chipped off.

COATING. Pipe intended for water conduits are now

heated up and immersed in a preservative liquid, usually gas house tar, which prevents rusting.

All pipe are placed in a press, gaskets placed at each end to prevent leaking, and are tested (water pipe to a hydrostatic pressure of 300 lbs. per square inch), and while under pressure are struck from end to end with a hand hammer to develope any latent defects.

The weight is now painted on the pipe, and sent to the shipping skids.

While rectangular pits with overhead travelers, circular pits with revolving linings, and other types are in use, the method of manufacture is in the main as above.

Soil pipe being cast very thin, and only about 4 feet long instead of 12 feet, are cast on the side in green sand molds and with green sand cores.

Among the communications read at the Philadelphia meeting was one from the Pittsburgh Foundrymen's Association, requesting an indorsement of a resolution passed at the last meting of that association, to the effect that trade schools be asked to take up the matter of teaching chemistry and cupola melting, as proposed by Dr. Kirk. Thomas Devlin offered the following addition to the resolution as passed by the Pittsburgh Association:

Resolved, That in view of the action of the Pittsburgh Foundrymen's Association on Dr. Kirk's proposal, the Philadelphia Foundrymen's Association recommend to all associations in the United States that they authorize the secretaries to ascertain by correspondence how many foundrymen in their district will give the free use of their shops, for six months or more, for instruction in cupola melting to one student in practical metallurgy, the student to analyze the iron, fuel and make a proper mixture to produce iron of suitable strength, softness and fluidity, the use of the shops to be given on the condition that the schools guarantee results.

Resolved, That we recommend that the secretary of the Foundrymen's Association correspond with technical schools and colleges that give courses in metallurgical chemistry to ascertain if

they will undertake such work as outlined by Dr. Kirk, and will guarantee the results to the foundryman on the condition that they obtain the free use of his cupola.

After considerable comment by the various members, both the original resolution and Mr. Devlin's addition to it were referred to a committee of five. The membes of the committee are A. E. Outerbridge, M. W. Shedd, A. C. Pessano, F. A. Riehle and E. E. Brown.

A letter was read from Geo. H. Hull, president of the American Pig Iron Storage Warrant Co., New York, in which he stated that it was uncertain whether he would be able to attend the meeting, and referred to some resolutions to be offered at the conclusion of the reading of his paper mentioned in the call for the meeting, and which resolutions were drafted at the suggestion of Secretary Evans. If the resolutions should not pass, the letter stated, the writer would not take their rejection unkindly; but if on the other hand they passed they would carry great weight and be a powerful aid toward rectifying the most serious trouble in the industrial machinery of the United States.

Mr. Stirling then read Mr. Hull's paper, which, like the literature Mr. Hull has previously presented to the association, argued the advantage of the pig iron storage warrant system. The following resolution, prepared by Mr. Hull, was then presented by J. S. Hibbs:

Whereas, Iron is the most important staple in the commerce of this country, and

Whereas, The iron business of the United States has upon several occasions suffered in consequence of an insufficient supply to meet the demand, which in each instance might have been avoided by accumulating, under the warrant storage system, an ample reserve stock of iron in years preceding these periods of famine. Therefore, be it

Resolved, By the Foundrymen's Association, that we favor the warrant storage system and request the members of the Association to encourage it, with the view of preventing like famines in the future. And we recommend the warrant storage system

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as a practical method of attaining this result, and suggest and recommend to our members that they establish and maintain a correspondence with one or more dealers in iron warrants, as well as their usual dealers in iron, to the end that whenever they make a purchase of iron they may do so by the method that they find most to their advantage in each instance.

Mr. Devlin was of the opinion that the paper and the resolution held out the idea that if the storage warrant system was in operation in this country iron could always be obtained, and at reasonable prices. The only way to gauge a matter of this kind, he said, was to take the experience of a country where iron was carried on such a system. He believed that in England and Scotland, where iron was sold in this way, there had been just as many advances in the prices of iron as in this country, and there had appeared to be almost as great a famine. If the storage warrant system was a panacea for all ills, England should not be as short of iron as she is to-day, with stocks reducing at the rate of about 70,000 tons per month. He did not think it would be advisable for the Association to go upon record as advocating the establishment in this country of the storage warrant system, unless the members could be assured that they could buy from the stock yards just the quality of iron they wanted, and this assurance he felt pretty confident could not be given. He did not think it would be possible to get the same iron twice. He objected to the system also on the ground that it would not act to keep prices steady, as it was easily seen that the situation in England was no better than here in this country.

Mr. Hibbs said he was under the impression that Mr. Hull, at a previous meeting, stated he would sell iron by analysis.

Mr. Devlin had no remembrance of such a statement, but undestood that sales would be made by fracture altogether. He moved that the resolution be laid upon the table until the people who were conducting the storage warrant yards made the statement that they would furnish any iron required, on a guaranteed analysis. Personally he had no objection to the system, but he did not think the Association should indorse it unless they knew

it to be all right. He did not think buying iron in a haphazard way a good thing for any one, and that was what buying by fracture amounted to.

Mr. Stirling shared Mr. Devlin's views, and seconded the motion.

Mr. Hibbs thought the matter worthy of more consideration. If laid on the table as suggested by the motion, it would pass into oblivion unless brought up under a new resolution. Why not, he said, refer it to a committee, or to the executive committee, through whom it could be brought up at any time in the future.

After further discussion Mr. Riehle moved as an amendment that the matter be referred to the executive committee. Mr. Davis moved in further amendment that the resolution be referred to the executive committee with instructions to report in the matter early in the fall; and on this motion being put to the meeting it was carried.

Mr. Devlin suggested that notice be sent to each member when the report would be presented. The chairman directed that the suggestion be conveyed to the committee as instructions.

There was a general expression of regret on the part of members that Secretary Evans was prevented by illness from attending the meeting. Mr. Stirling moved, seconded by Mr. Devlin, that the sympathies of the members of the Association be conveyed to Mr. Evans, with the hope that he would speedily be restored to health, and resume his secretarial duties. The motion was carried unanimously by a rising vote. The meeting then adjourned.

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PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The resolutions prepared by Geo. H. Hull, president of the American Pig Iron Warrant Storage Co., for indorsement by the various foundrymen's associations, met a summary fate at the meeting of the Pittsburg Foundrymen's Association. The resolutions were submitted in the form printed elsewhere in our report of the Philadelphia meeting, and without much ceremony action was indefinitely postponed.

NATIONAL ASSOCIATION OF STOVE MANUFACTURERS.

At the annual convention of this association, recently held in New York City, James A. Green, of Matthew, Addy & Co., read the following paper on "The Past and Future of Pig Iron":

We Americans are notoriously worshipers of big things. Our cities annex everything contiguous to them, so as to be ready to make a big showing in this year's census. We used to think we had a big enough country, but since the Spanish war we have been expanding so that now we really have an imperial domain, above which the Stars and Stripes are forever bathed in the sunshine, and orators no longer have to drag in the old chestnut to the effect that as the earliest ray of dawn strikes Eastport, Maine, the last ray of the dusk still lingers on the most westward of the Aleutian Islands. We have, of course, the biggest water fall in the world; we have the longest river; we have the biggest fresh water lakes; we have the biggest multi-millionaires; we have the biggest trusts; we have the most soaring sky-scrapers; in fact, the American boy who is brought up solely on the ordinary American sentiment might well think that we are so big that the rest of the world is after all a mere adjunct to America, a mere something to make our bigness apparent by comparison. This worship of bigness is a dangerous thing, for it is always quality that in the final analysis counts more than quantity. Xerxes had a million men in the army with which he invaded Greece; the Greeks were but a handful, yet they humbled the pride of the Medes and Persians. Athens was not a great capital of the ancient world, yet its art is still unsurpassed. Jerusalem was only the insignificant city of an inferior nation numerically, yet it gave religion to all the world. The Armada was so mighty that it was deemed invincible, yet a vastly smaller fleet annihilated it.

Possibly it is too much of a drop from these historic instances to such a hard and dry topic as pig iron, yet it is well to remember that even in pig iron bigness is not everything. In pig iron

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we certainly are big. We lead all creation. As far as tonnage goes, we have now distanced our foremost rival, Great Britain, and put her permanently in the rear. America never had such a year for pig iron as 1899, although 1900 will be greater. Last year we made 13,500,000 tons of pig iron, and this year we bid fair to make it 15,000,000. But the mere bulk of pig iron produced will not win complete supremacy unless we see to it that in the finished forms of iron we lead the world and supply the world as well. And it is pleasant to remember that in speaking to American makers of stoves I am addressing one great branch of the trade where admittedly we have neither equals nor superiors. Our greatest philosopher, Franklin, thought it worthy of his genius to invent a stove, and you philosophers have been helping in your day and generation to serve humanity along the same splendid lines. If there is anything which shows how far ahead of all competition are American stoves, it is to take up a catalogue of some foreign stove foundry and see the wretched imitations of the genuine American article. The other day I saw the trade list of a Scotch foundry that was trying to imitate your goods. Imitation is the sincerest flattery, but the imitation was so bad that I fear there was no flattery in it. The form was there, but not the substance. Those stoves would neither burn nor draw. Our English friends are great in denouncing American publishers who steal their copyrighted books. But they say little of Englishmen who steal our stove patterns, who copy our machines, and who in general try to steal our Yankee brains. These particular Scotch-American stoves reminded me of some enterprising publishers who try to evade the copyright law by taking a story, changing the punctuation, leaving out a word here or a sentence there, and altering the names of the characters. But they had so botched your handiwork that I am sure you would not claim it even as a Kentucky cousin.

But I am getting somewhat away from my topic. It is difficult to imagine just what 13,665,015 tons of pig iron means. If it were all shipped in even 20-ton carload lots, it would take 683,250 cars to carry it. And if these cars were all loaded at the

same time, there would be 5,176 solid miles of freight cars. The distance between New York and Philadelphia is 90 miles, so if the P. R. R. attempted to sidetrack those cars on that division, instead of the present four tracks they would need 57 tracks. It is 758 miles from Cincinnati to New York, and those cars would need seven tracks from Cincinnati to New York to accommodate them. Or if all that iron had been made into steel rails, it would have been sufficient to lay 96,230 miles of single track 90-pound rails. This means that we might have girdled the earth four times at the equator less a little fraction. And if we had spun it into wire, we might have fenced in the whole planetary system. The mere magnitude of it expressed in these visible and concrete forms is stupefying. And not only are the figures in this way tremendous, but if you put it in dollars and cents they are more wonderful. It was the money side of last year that made more impression than any other. Pig iron at Birmingham advanced from $6.75 in January to $16 for gray forge in December. Pittsburgh, the greatest of American iron centers had a larger proportion of increase in her bank clearing in 1899 than any other of our cities. And the most wonderful part of this great increase in price was that it hurt no one. You gentlemen, I am told, sold more stoves last year than ever before, and your customers were eager to pay the advanced prices. In fact, the boom of 1899 in this regard was as Portia said of mercy:

"It blesseth him that gives and him that takes."

As far as I can see, it was the greatest thing commercially that has happened to the country for many years. It stimulated every branch of industry. It increased the wages of labor and made labor plentiful. It gave capital the return which years of hard times had denied. It gave enterprise every opportunity, and while the stove men escaped being formed into a trust, though I believe they tried hard to achieve the common fate, yet there never was a year so prolific in trusts, and if trusts do what I believe history teaches—that is, reduce the prices of the commodities they furnish the public—its good results in this direction will long be enjoyed. But no great year like this can come

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and go and leave things as it found them. We were growing stale and rusty, we were getting pessimistic, and were looking through blue glasses. We realize now what has been, may be and indeed is. We have a better idea of ourselves and our possibilities, and without a proper self-esteem progress is impossible.

As for myself, I believe that 1899 opened our eyes as a people to our plain and Manifest industrial destiny. It is incidents like that of the Atbara River bridge that permit us to measure ourselves by the side of others. In the fall of 1898 the British War Department decided to bridge the Atbara River, so as to give Kitchener's army a sure line of supplies across the desert. It was necessary to complete the bridge before July, '99, when the annual floods were to be expected. To make a long story short, the plans were not ready until December, and then it was found no British firm could promise to get the iron work ready in less than six months. The bridge makers of the world in this extremity were invited to compete, and an American firm, the A. & P. Roberts Company of Philadelphia, took the contract, they being able to promise quicker work, and I think better, too, than any of their competitors. And what they promised they performed, and there in Upper Egypt stands to-day that silent witness to the energy and enterprise of Americans. On the mountains of Peru, across the hot plains of Australia, puff American locomotives. That tremendous railroad that the Czar is building across Siberia to the Pacific is largely laid with American rails and equipped with American locomotives. Those gold mines down Johannesburg way, of which we hear so much these days, are worked entirely by American machinery. Not only in the harvest fields of Argentine, but in the harvest fields of England and France, our agricultural machinery is to be found. How far afield you gentlemen send your stoves I don't know, but I am sure that if you had your deserts you would all be obliged to immediately double the capacity of your works to take care of the export trade. I mention a few of the achievements of our American workers in iron, yet because of these there is no need to think we have achieved the full measure of our possi-

bilities and sigh, like Alexander, for more worlds to conquer. On the contrary, we have only made a start. I believe that 95 per cent of our exports had to leave America in foreign ships. We should every year be using thousands and thousands of tons of pig iron in building ships. As a matter of fact, this use of pig iron now is insignificant. Here in Alabama we are exporting large quantities of pig iron yearly, yet it is humiliating to acknowledge that we are entirely dependent for this export business on foreign bottoms. This hampers the trade; with American ships we would see our export business grow until where there is now one furnace in Alabama there would be two, and where for every dollar that now comes to the ironmaster from abroad there would be twenty. And the banks of the Hudson, the Dealware and the Chesapeake would be as busy as are the banks of the Clyde. This is no dream. It is only the statement of a future fact. Of course, all this is based on pig iron. The performances of the past are warrant enough of what we can do in the future.

I have no intention of alluding to the pig iron market. Were it possible for me to give any of the gentlemen here present a straight tip that would put money into your pockets and into mine, too, I should be glad to do so. Pig iron, fortunately, is not a Wall street commodity. Wall street, indeed, obediently follows rather than leads it. Its fluctuations, while wonderful in their extremes, are due to the law of supply and demand, and whether we are suited or not, we cannot well repeal that law, as a Chicago alderman once moved to do. Personally, I may say that I do not think this year's supply of iron is going to exceed the demand, and that unless the unexpected happens we are going presently to have the same trouble we had last year—that is, not enough to go around. Matters may be quiet now, but quietness is not stagnation. Lord Roberts seemed, after his great forward movements, to stop rather short at Bloemfontein, but is now going ahead again irresistibly.

In conclusion, I beg to finish as I began. In no great industry has America made a better showing than in pig iron. But

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to capture the trade of the world we must not only be able to make the best and cheapest crude pig, but we must put it on the market in the best shapes of its million finished products. And if all other branches of the trade used pig iron to the same advantage as do the American makers of stoves—that is, in turning out an article that cannot possibly be surpassed—then the future of American pig iron would be too great for us to grasp with our small nineteenth century ideas.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

IRON TRADE REVIEW.

Under the caption, "What the Founder Still Asks of Chemistry," Edward Kirk says:

For many years foundry irons were selected and mixed for various grades of foundry work by the indications of fracture in the pig. This mode of judging the quality of irons was deceptive to those not expert on fracture indications, and hard iron was frequently produced from the cupola when a soft iron was desired, and a soft iron when a hard iron was required. To overcome this uncertainty of resultant mixtures, the aid of chemistry was invoked, and it was found that the element silicon exerted a powerful influence upon cast iron, in determining the degree of hardness or softness. Upon this discovery a series of experiments was made, to determine the amount of silicon that an iron should contain, to run hard or soft in the various classes of castings. And a system of mixing iron upon what may be designated a silicon basis was established.

This system indicated the proper amount of silicon that an iron should contain to be suitable for very light castings, medium castings, heavy castings, malleable, etc. Since the establishment of this system, the expression "elements in iron" has been changed to metalloids, and numerous large words have been added to the chemical foundry dictionary. Of what advantage has all this been to the foundry industry? Has the quality of foundry iron been improved, or the life of castings increased, since the introduction of this system? It has not. On the other hand, it has decreased, and numerous lines of work have been lost to the industry, such as cranks, gear wheels and parts of machinery requiring great strength and wearing properties, street car track work, crossings, turn outs, switches, steam car track castings and architectural iron work.

Why have these lines of work been lost to the founder? Simply because a material more suitable for the purpose has been

found in steel. Whence is this material obtained? It is produced from pig iron, made from the same ores that foundry irons are made from. By the aid of chemistry, a steel is produced from anthracite and coke iron as good, if not superior, to that made from the best of charcoal iron, by the crucible process, before the introduction of anthracite and coke irons. And this at a sufficiently reduced price, as compared with crucible steel, to replace cast iron for many of the purposes for which cast iron was formerly used.

If the chemist can produce a steel from anthracite and coke iron equal or superior to that obtained from charcoal iron, then why cannot the chemist produce a foundry iron equal or superior to the hot and cold blast charcoal foundry irons of years ago? With such an iron, the foundry industry can hold its own; without it, it must lose many lines of castings to steel, which it cannot afford to do; for if the industry continues to lose lines of work for the next twenty-five years at the same rate as it has in the past ten years, the general cast iron foundry business of the country will be reduced to the making of grate bars, sash weights and chunks. And the specialty foundries will lose many of their present products.

What can be done to prevent the retrograde action of this great industry in which millions of dollars are invested? is a question that should be seriously taken up and seriously considered by every foundryman and every foundrymen's association of this country. In my opinion, the industry can hold its own only by an improvement in the quality of foundry iron. Can the quality of foundry iron be improved by the present silicon-basis system employed in foundry chemistry? It cannot. For this system reaches the limit of its usefulness when it determines the degree of hardness and softness in cast iron. Beyond this it cannot go, for in every other respect silicon is a detriment to cast iron, and the sooner this system is discarded the better it will be for the founder. Not only has this system failed to improve the quality of foundry iron in the hands of the founder, but it has served to deteriorate it by inducing blast furnacemen to increase the per

cent. of silicon in foundry irons to such an extent that the founder is no longer looking for high silicon, but low silicon iron.

The true softener of cast iron, as of steel, is carbon. By the increase or decrease of this element steel is given any degree of hardness or softness desired, and the chemist who discovers a process of eliminating silicon from foundry iron and controlling the carbon at a moderate cost will reap a fortune. This can no doubt be done, and will be done, when the founder and the chemist get together, as have the manufacturers of steel and the chemist. But so long as the chemist is a mere analyst to the founder there is no hope of accomplishing anything in the way of improving foundry irons.

Can the foundry chemist produce from the present stock of foundry irons, when melted in a cupola, a superior grade of iron to that now obtained? This is very doubtful, for the length of time required to melt iron in a cupola is not sufficient to admit of any radical chemical change being effected in the iron.

To produce a better grade of iron at the spout, the chemist must have a different grade of pig iron from that commonly supplied to founders from which to produce it. The men to supply this iron are the furnacemen and his chemists. These men have been endeavoring to supply the founders with high-silicon iron ever since they indicated that silicon iron is what they wanted, and they will no doubt endeavor to produce any other kind of iron the founder wants.

Let the founder and his chemists get their heads together, and find out the constituents of a first-class foundry iron for the various lines of work. Give this to the furnacemen, and if one of them cannot produce an iron to correspond with the analysis of irons desired, a number of them may produce irons from which the foundry chemist can obtain by mixing from analysis an iron better suited for the various classes of work cast in foundries than that obtained at the present time.

AMERICAN MACHINIST.

Referring to an article contributed to this journal by Mr. J. E. Johnson (see A. F. A. Journal for May), Mr. Thos. D. West

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writes of the "Effects of Remelting Iron and Scrap Steel in Changing the Carbon and Other Metalloids," as follows:

The very able article of Mr. J. E. Johnson, Jr., exhibits broad experience and observation in the subjects treated. I am pleased to note that Mr. Johnson endorses the discoveries made by me in remelts of chilled iron being softer than those of the gray iron to come from the same casting or the same grade of iron, as such will assist in causing founders to abandon the old practice of thinking it necessary to set aside the chilled parts of car wheels, plow points, etc., from the gray portion of such castings, for fear of the chilled parts hardening mixtures intended for machinable work, etc.

Mr. Johnson, in referring to the changes due to remelting, says: "Some carbon is always burned out in remelting pig iron." I also had supposed such to be true, until I made some experiments on this point, and then I found the contrary to be the case, as may be seen by a study of tables 1 and 2:

TABLE 1.

CHANGES OF ANALYSES IN REMELTING PIG IRON FIVE TIMES.

	Charcoal Pig Iron.	First Remelt.	Second Remelt.	Third Remelt.	Fourth Remelt.	Fifth Remelt.
Total Carbon	3.94	4.10	4.30	4.47	4.68	4.76
Graphitic Carbon	3.06	2.90	2.42	2.90	2.67	3.16
Combined Carbon	.88	1.20	1.90	1.57	2.01	1.60
Silicon	.82	.75	.63	.66	.57	.59
Sulphur	.02	.03	.04	.04	.045	.048
Manganese	.78	.66	.53	.31	....	.25
Phosphorus	.232	.248	.274	.237	.254	.271
Specific Gravity	7.01	7.30	7.35	7.40	7.47	7.46

TABLE 2.

CHANGES IN ANALYSES IN REMELTING SCRAP STEEL THREE TIMES.

	Scrap Steel.	First Remelt.	Second Remelt.	Third Remelt.
Total Carbon	.60	1.48	2.74	3.05
Graphitic Carbon	...	....	....	.15
Combined Carbon	.60	1.48	2.74	2.90
Silicon	.31	.26	.14	.35
Sulphur	.02	.10	.14	.18
Manganese	.34	.23	.15	.06
Phosphorus	.106	.167	.190	.198

We find in Table 1 that, starting with the pig iron containing 3.94 total carbon, five remelts gradually raised it to 4.76, an increase in the total carbon of nearly 1 per cent. To check these results with a metal having a lower carbon than charcoal pig iron, I took some scrap steel, having .60 carbon, and, as can be seen by a study of Table 2, three remelts of this steel raised it gradually to 3.05, an increase of total carbon in this case of nearly 2½ per cent.

The above tables are of value not only in showing the effects of remelting on the total carbon, but also on the silicon, sulphur, manganese and phosphorus. The tables show that the silicon and manganese are decreased, while the sulphur and phosphorus are increased, the latter very slightly, which facts are well established in the general practice of founders melting in cupolas.

A point rather peculiar in the above tests is that seen in the silicon being increased in the third remelt of both tables. It would look as if there were something more to be learned on this point.

On the whole, the silicon is not reduced as much in the heats above tabulated as is found in general practice, with regular heats. The same can be said of the increase in sulphur, which is rather small. These two latter factors may be due to my experiments having been made in a very small cupola, in which the metal came down very fast. This fast melting would not leave the iron subjected to heat to burn out the silicon or increase the sulphur as long as is generally the case in every-day founding. Looking at the matter from this standpoint, we would have to conclude that still more carbon would be added to iron by remelting in general practice than is exhibited in the above tables, the analyses of which heats were kindly tendered the writer by Dr. R. G. G. Moldenke.

I believe it to be generally thought that more or less carbon is burned out by remelting iron, but is there any evidence that such is the case? The above tables are the only ones that I know of, giving the results of actual experiments, to test the question of the effect which remelting has on the total carbon. If there

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are any others having actual tests or records on the subject of carbons to show the contrary to that displayed in the above tables, it will serve the interest of founding to have them made known, as other conditions than those of the tests here recorded might give other results; but from a study of the above tables it would seem that there is a strong tendency for iron and steel to absorb carbon when remelted in contact with coke in cupolas, as was the case in the above experiments.

IRON MOLDERS' JOURNAL.

Commenting upon the different ways of working witnessed in foundries, Thomas A. Haigh says:

As one travels and works in different jobbing shops, he sees a good many different ways of working. Some shops would never think of bedding a piece in the floor, while another shop would not think of rolling a large piece over unless it was impossible to get a good bed without it. Another shop will use skim gates on everything, and others will very seldom use them, while some never use them at all, but use "pop" or "pencil" gates instead, if not on the casting direct, they will use them on the joint, and, as far as I have seen, produce just as good results. In fact, I think the "pencil" gates are not used enough (if the sand will stand it) as a good, clean casting is assured if the gates are not too big and the runner basin is kept full with a fair quality of iron. With some iron we get, it is impossible to get a clean casting. Another thing in favor of pencil gates on top of a casting is that there is not the same strain on a mold.

Another custom in some shops is to put lots of gates on a casting. Of course some castings demand such treatment, either to keep them straight or to run them. I worked in a shop once where the foreman made an 8-inch column, 10 feet long, 1 1-4-inch metal, and put a crane ladle, 2 "bulls" and some hand ladles on it; while another shop would only put a crane ladle on. I worked in a shop where a foreman made a plate 10 inches wide with a rib 3 inches deep, on one side, 10 feet long and 2 inches thick. He bedded it in the floor, putting one end about 3 inches

lower than the other, so that it would run. It was cast, and when it came out it was about half an inch thicker at one end than the other. It was broken up and the next one made on the level, which was all right. Another thing came under my notice in a shop where very heavy work was made relating to the use of the feeding rod. Some of the men would feed their work up all right, but others, when feeding a piece, would take the rod out when the casting was very liquid and the rod was away down in the casting. As these castings had to be solid and stand a test, the consequence was there were more broken up than were good, and when broken they showed the deep shrinkage, through (in my estimation) insufficient feeding. In this same shop, no matter how thick a casting might be, they would never use a rod more than half an inch thick. While I would not be sure that a thicker rod would be better, yet I have the impression that it would, and I certainly would have used a five-eighths inch rod on the castings that shrunk. I believe a five-eighths inch rod would not have produced a worse result, at least.

I would like to get the views of some of our members as to whether a small rod or a thick rod is beneficial for feeding heavy works.

In a short sketch of some leading foundries in Cincinnati, the Iron Molders' Journal contains the following:

Cincinnati, from away back in the late fifties, has always been a considerable foundry center. In the early days before the steam railroad was a quantity in trade and commerce the contiguity of such a waterway as the Ohio River and its confluence with the Mississippi gave such cities as Pittsburg, Cincinnati, Louisville and St. Louis a very material advantage over inland towns. The south was not a factor in the iron industry of these days, and these river cities looked after its needs in that line. Cincinnati was a rival of Pittsburg in river marine work and the building of marine engines and steamboat work kept a considerable number of machinery and jobbing molders well employed.

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In the sixties the stove trade had become a feature of Cincinnati's foundries, and during and after the war it flourished like a green bay tree. In 1866 it has been estimated that about 650 stove plate molders were employed in Cincinnati. Among the well known names in the stove manufacturing industry of those days might be mentioned Resor & Co., Chamberlain & Co., The S. H. Burton Co., better known as Greenwood's, Redway & Burton, Adams & Peckover; and then crossing the river, for you are really still in Cincinnati, we have the Geo. W. Ball Co., The Wm. C. Davis Co., of Newport, and the I. Droege & Co., later known as Bogenschutz & Co., of Covington; and proceeding up the river a few miles the Nich. Patterson Foundry Co., of California, O. When river navigation gave way to the steam railroad, the river cities ceased to have an advantage, distances were eliminated to a degree and the stove trade slowly drifted away, following the markets westward and northward and distributing itself in the smaller towns of the State, which were then offering bonuses for the location of factories in their jurisdiction.

Cincinnati and vicinity is no longer a stove-plate center, a small remnant now being all that is left of its former greatness. Resor & Co. is still in existence, but their really fine molding shop has of late been run with a small force for a few months each year, although better things are now looked for. Then there is the Goodwill on the site of the Adams & Peckover foundry, and within the last two months the Schulte Range Co. Across the river there is only the Star Foundry and Bogenschutz & Co. representing the stove trade.

Grate and mantle making was also a feature of Cincinnati's foundries in the sixties and seventies, and to old-timers the names of Innis & McGill, Hand, Innis & Whitehouse, and C. S. Rankin are still familiar. Other concerns embarked in the industry, but this, too, has recently dwindled away to almost nothing. Louisville has captured the greater portion of what is left to the trade in these markets, but ideas have changed in this kind of work as in nearly every other, and there is no longer the same demand for it.

Cincinnati has not ceased to be a foundry center, however. While these branches of the industry have left us, others have sprung up. It has ceased to be a stove-plate center, but it has developed into one of the greatest centers for the manufacture of wood-working and iron-making machinery in the country, and, if we include the Niles Tool Works, of Hamilton, O., this vicinity is said to be the greatest machine tool producing district in the world. The local manufacturers are no longer mere understudies of eastern machine tool builders, but are their equals, and some say superiors, both in design and output.

Including the U. S. Pipe & Foundry Co., situated at Addyston, O., there are about twenty-three jobbing and machinery foundries in Cincinnati and six in the neighboring cities across the river, including the two stove foundries which take in jobbing and furnace work. Some of this list are, of course, small foundries, but the greater number of them employ a fair force of molders.

The Hoefinghoff & Laue Co.'s foundry, located at Front and Lawrence streets, on the site of what was formerly the Niles Tool Works, and later the Wm. C. Davis Co.'s stove shop, is the most distinctively general jobbing shop of any in the city, although all are, properly speaking, general jobbing shops, but are largely engaged in making machine tool work in some of its forms, thus more nearly approaching the specialty shop. Hoefinghoff's, as it is commonly called, employs, as a rule, the largest force of molders of any in the city; between 80 and 90 has, during the past year, been about the average.

The Eureka Foundry on Richmond street is also a general jobbing foundry, although, like the others, it is largely engaged in making machine tool work. It is, perhaps, the best equipped of any in the city to handle large work. It has a steam crane of 25 tons capacity, and employs a force of journeymen molders that will average from 65 to 75 men. There are two cupolas with a possible joint capacity of about 80 tons. These are fitted with Hardert tuyeres, which will be referred to later in this sketch, and are highly commended by the management. As an example of

the work that can be successfully handled in this shop, we are informed by the superintendent that they have an order now for two shear housings that will weigh about 23 tons each.

There are so many others that we must on this occasion pass them by with a simple mention. Among them are Thauwald's, Vulcan, Phoenix, Greenwald's, Globe, Jones & Bruce, Erhart's, Foley's, Lane & Bodley's and others. Lane & Bodley confine themselves largely to engine building and the I. & E. Greenwald Co. to engine and milling machinery work. Across the river we have the Western, Schuh & Martin, Newport Iron and Brass Foundry Co., Covington Foundry Co. and another shop of the U. S. Pipe & Foundry Co., the latter, as its name implies, and the shop of the same company in Addyston, O., being pipe shops with the usual jobbing foundries attached for making their fittings and specials. In making comparisons, if we include the pipe shops of the U. S. Pipe & Foundry Co., these are, of course, the largest foundries in this vicinity. Molders are not employed in making straight pipes, at least not molders in the sense in which we use the term.

As a rule, the foundries of Cincinnati are old shops, many of them, it is true, improved and patched up to accommodate them to changed conditions, but two—the Buckeye Foundry and the Queen City Foundry—are new foundries built to meet the necessities of rising young firms that found their old premises inadequate. Being new, their equipment is more up to date, they have better light and are better able to handle successfully thir respective specialties.

The Queen City Foundry Co. is the oldest of these two, and is a reorganization of the old Queen City Foundry Co. The original foundry was on West Fifth street, just west of the C., H. & D. depot. At the outset the principal work was woodworking machinery and general jobbing with a sprinkling of grate and mantel and plumbers' supply work. Some time after the Laidlaw-Dunn Pump Co. was organized and the Queen City Co. secured their foundry work, which amounted then to about one ton of castings per day. About 18

molders was the average staff of the old foundry and the melt about six tons. As time went on the Queen City foundry gradually began to drop out from the machine tool trade and devoted its attention to pump and a better class of machinery work. It became evident that the old plant was not adequate for the larger class of work it was called upon to do, and a site was chosen for a new brick foundry at the corner of Spring Grove and Alabama avenues. On August 8th,1899, the first heat was run off in the new shop. One continuous stretch of side windows and skylights furnish excellent light, the roof is high and excellent provision made for ventilation. The molding room is 91 feet by 182 feet, the core room and ovens being in an off-shoot building about the center of the shop, while the cleaning and mill rooms are at the end, thus keeping the foundry free from the clatter and dust of these useful but annoying adjuncts. The floor space is completely covered with traveling cranes. On the main run, down the center of the shop, there are at present three travelers of respectively 5, 7 and 8 tons capacity, with a fourth one of 16 tons capacity ordered to be put up as soon as possible. On the sides there are four 5-ton travelers. The shop is fitted with electric lights throughout and supplied from their own dynamo. The cupola is a Whiting fitted with a Root blower and having a capacity of about 10 tons an hour. On an average from 30 to 40 molders are employed, nearly all on a heavy class of good pump work, together with gas engine and hydrauluic press work, which requires the highest degree of mechanical skill both from the molder and the coremaker. The average output is 300 tons of clean castings monthly.

In front of the foundry building, facing Spring Grove avenue, is a three-story brick building, 40x100 feet. On the first floor are the office rooms, carpenter shop, and pattern room, while the two floors above are used as pattern store rooms. In the yard we find an elevator operated by steam power for hoisting the charges for the cupola and a 50-foot jib fitted to do service as a crane or as a drop, also operated by steam power. Altogether, it is a foundry of which the proprietors may be justly proud and

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will compare favorably with any foundry of its kind in the country.

Like the Queen City, the present is not the original Buckeye Foundry. The old shop was on Central avenue, and is now the Vulcan Foundry. The company was originally a sort of co-operative concern organized in 1888, and started in as a general jobbing shop, an average of from 25 to 40 molders being employed. The young concern had a rough road to travel for a time and the partners had to work like beavers to make headway. They got there, however, and being far-sighted enough to realize that Cincinnati was fated to be a great machine tool producing center, they gradually drifted into that class of work as a specialty. In 1896 the new shop was built, and we have the Buckeye Foundry as shown in the cut. It is also in the west end of the city, on Buck street, just a stone's throw from Thauwald's foundry and works. In the new shop everything was adapted to the needs of their specialty, which includes lathe, milling machine, radial drill and shaper work, of which about 400 tons of clean castings are turned out monthly. Lathes ranging from the smallest size to the 30-footer, 28-inch swing, are here turned out, and facilities for their making furnished the molder which have been designed with a view to minimizing his labor and making it most productive. Instead of the wooden flasks with barred cheeks, which were eternally being burnt out and replaced, wrought angle iron flasks are used, the cheeks of which are fitted with cast iron grids to carry the sand and minimize "gaggering." Cone pulleys and head stocks are made without copes, while there are no fewer than nine travelers overhead, so that there will be no undue delay through waiting for the crane. Of these cranes there ar four in the main or central run, 2 of 10 tons and 2 of 5 tons capacity and on the sides three of 3 tons and two of 2 tons. The provisions for lighting and ventilation are good, the shop is furnished with electric lights and steam heat throughout. The main shop is 90x180 feet and a later addition 45x90 feet. The average molding force is from 50 to 65 journeymen. The cupola is a Whiting fitted with tuyeres designed by their former cupola man, which have proven such a success that he has quit cupola tending to push their in-

troduction. They are known as the Hardert tuyeres, and Mr. Charles Lange, of the Buckeye Foundry Co., is sponsor for the statement that they enable them to charge with a ratio of 120 lbs. coke to 2,000 lbs. iron and, including the bed, in an ordinary heat to melt with a ratio of about 1 to 14. These tuyeres are used in several other foundries in the city. In the yard we find a hydraulic elevator with automatic pump for hoisting pig iron and fuel to a scaffold built of iron and steel to minimize the danger from fire. A large area of the yard is roofed in to furnish protection from inclemency of weather.

Forming the cross part of a T to the foundry is a two-story and basement brick building, 36x100 feet, facing on Buck street. In this are the office apartments, cleaning and shipping rooms, and a well-equipped pattern and carpenter shop, the former being an adjunct for the greater convenience of customers desiring changes to be made, while overhead are the pattern store rooms. With this description we dismiss the Buckeye Foundry and leave it to our readers to give credit where credit is due.

In such a sketch as this, covering, as we have attempted, so much ground, it has been impossible to give as much notice to each foundry of the city as we would have liked, but enough has been said to enable the reader to form a fair estimate of Cincinnati and its foundries, and that was our design.

THE FOUNDRY.

In "Cast Iron Notes" W. J. Keep answers the following questions:

Question: We are desirous of obtaining some more information from you. How do you determine the amount of silicon the iron contains by testing it? We send you two bars, one-half inch square and the other one inch wide flat. We would like you to test same and let us know the result as to the amount of silicon they contain, and, as above requested, tell us how you determine the amount of that ingredient. Further, if two bars are poured from the same iron but of different dimensions, will they vary in silicon, or otherwise? Does rapid cooling destroy

the silicon? We think with this information we will be able to make tests and get satisfactory results with any iron that we may mix.

Answer: I am glad you have asked these questions, and will try to answer them plainly. Carbon in iron will always remain in the combined state, and the iron will be hard and white, unless some influnce changes it into graphite, when the iron will be gray and soft. Silicon turns hard white iron into soft gray iron. Iron which would be white if cooled rapidly will be gray if cooled slowly enough.

A large casting will cool more slowly and will be grayer than a small casting poured from the same iron, but the silicon will be the same in each. If the silicon is in the melted iron, it will be in the casting whether coolel fast or slow.

If the iron runs against an iron chill it may cool so rapidly that the silicon will not have time to change the carbon into graphite, and the iron will be chilled white. If it cools very slowly the silicon has a longer time to exert its influence.

To produce the same grayness in a small casting, more silicon is needed than in a large casting.

There are other elements in cast iron than silicon, and they modify the influence of silicon, as does fast and slow cooling.

A given percentage of silicon for these reasons does not always produce the same influence.

The founder cares only for the physical quality of his castings, grayness, hardness, size of grain and depth of chill. As we cannot depend upon any given percentage of silicon to produce a given degree of these physical characteristics, we must vary the silicon to keep these qualities uniform.

Fortunately a given shrinkage accompanies a given physical quality. A measure of shrinkage is, therefore, a measure of the influence of the silicon present in the casting measured, but not the influence of the same silicon in another casting of a different size from the same iron.

If you are making castings of a certain size which have a cer-

tain quality that is satisfactory, make a test bar of the same iron and measure its shrinkage.

If you maintain this shrinkage you will maintain a uniform, physical quality. If the shrinkage is greater, the castings will be harder, the chill deeper and the color lighter.

Increase silicon by increasing the iron of your mixture that contains most silicon and the shrinkage will return to your standard. If the shrinkage is less, you can increase the cheaper irons until it again reaches the standard.

You do not need to bother about the percentage but about the influence which you see in your castings.

If you want to approximate the percentage or rather know what percentage a chemist would expect to produce such physical characteristics, you can use a table of shrinkages of irons of known silicon contents, and by finding the shrinkage of your test bar you can see what silicon in that case produced a similar shrinkage.

This would be as correct an approximation as you would be likely to get from chemical analysis.

You sent me a test bar half an inch square, asking me to test it. The test is to measure shrinkage. You must place the test bar between the same chills that were used in the mold and measure the shrinkage yourself. I cannot measure the shrinkage, because the bar must be measuured in its own chills.

I notice that you have ground the sides of the test bar. The sand should be rubbed off, but the center of the bar should never be ground.

Strength does not depend upon the chemical analysis, but depends upon the character of the grain.

By experimenting you will find which mixture of your irons gives you the strongest castings. I wish that you would practice what I have suggested and then write me again, giving results, and tell me what I can do to make the matter more clear to you.

Since writing the foregoing I have received a reply to the above, in which the writer says:

"After reading your letter carefully I find that we are work-

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ing upon the same lines that you are. In the first place, we take each iron separately; we make a test so as to determine the percent of silicon it contains, then combine the whole to obtain the desired results. I am also preparing a key by the shrinkage of each iron separately; for illustration, if an iron, we will say No. 1, from a crucible test shows a shrinkage of .125, I take it by that the iron contains 3.25 per cent of silicon, and so on down the list of the various kinds of iron. By the increase of shrinkage we decrease the percent of silicon. By this method it enables us to govern our mixtures very satisfactorily."

Writing of "Burned Iron," Edward Kirk says:

Burned cast iron presents the most varied as well as the most deceptive fracture of all the irons the founder has to deal with. The variations are due to the extent to which the iron is burned and also to the conditions under which it was burned. The deception is due to the changes effected in the crystalization of the iron by frequent or prolonged heating.

In a grate bar, we may find near the center a small crystal of a light bluish cast, and near the ends a large crystal with a dark blue cast. This is due to the center having been subjected to a greater heat than the ends. In heavy retorts, etc., we find a large crystal and open iron, presenting many of the characteristics of fracture in a very soft No. 1 pig iron. And, in fact, in all burned iron, not burned in contact with fuel, we find in the fracture the characteristics of a soft iron.

The mistake commonly made by founders and melters is in judging this iron by the fracture, which in reality indicates nothing as to the quality of iron that may be melted from it. Grate bars are frequently broken and the center condemned and thrown in the dump, while the ends are melted, simply because the fracture near the end indicates a soft iron. Pieces of retorts and other burned castings are melted for the same reason that should be thrown away.

All burned iron should be judged by the external general appearance, and not by fracture. By general appearance is

meant the entire casting should be considered, and not certain parts of it, as is too frequently done.

In burning away the surface of a grate bar near the center, the ends are subject to a prolonged heat, of a degree lower than in the center, but sufficient to destroy the iron; although none of it may have been burned away near the ends, and the external appearance gives no indication of the iron having been injured, the same rule applies to a greater or less extent to all castings, parts of which show indications of having been burned.

This principle is frequently better understood by junk dealers than founders, and in sorting scrap unprincipled dealers break off parts of castings showing external evidence of having been burned, throwing it in the burned iron pile, while that showing no evidence of being burned is thrown in the good scrap to be sold to founders, who judge scrap by fracture only. Retorts, pipes, salt kettles, etc., are broken into plates, slabs or pieces to destroy their identity, and thrown in a pile to rust before being placed with good scrap, a few pieces to the ton, to be sold as good scrap. This is one of the tricks of trade that founders have to look out for, to avoid unknowingly melting burned iron for their castings.

Burned cast iron in all cases, when melted in a cupola, produces a hard iron. The degree of hardness depends upon the extent to which the iron has been burned, from that only slightly burned, a hard gray or mottled iron may be obtained. From that burned to a greater extent, a white iron, and from that burned to a still greater extent, a very small per cent of white iron, with an excessive amount of slag. These three grades may be found in a promiscuous lot or pile of burned iron, and, when melted alone, the product is generally a white iron, with a large amount of slag. The slag may boil in the cupola and stop melting or may flow from the tap hole with the iron, and in some cases cannot be distinguished from it until it has cooled to a considerable extent.

We have seen a large ladle full of this slag carried to the mold under the impression it was iron, and the mistake not discovered

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until an attempt was made to pour it, when it was found the slag could not be held back with a skimmer, and when dumped into the pig bed and cooled it was found there was only a few pounds of iron in the bottom of the ladle; all the remainder being slag, although it had all the appearance of molten iron, as it flowed from the tap hole and spout.

The melting of an entire heat of burned iron is generally a very unsatisfactory operation, and when once tried is seldom undertaken again by the same founder.

The nature or quality of an iron when burned is completely changed, and when melted with the same grade of iron from which it was made, does not enter freely into combination with it. The change effected varies with the extent to which the iron is burned. That only slightly burned enters more freely into combination with a soft iron than that badly burned. When melting this iron with a soft iron, we may find it in castings combined only to a limited extent with the soft iron, and forming hard spots, or we may find it in thin plates, sandwiched in between two thin plates of soft iron. And in heavier castings, in nodules, separate and distinct from the soft iron.

More commonly it enters into combination to some extent and forms hard spots, and hard spots in castings, especially in comparatively heavy castings, can more frequently be traced to burned iron than any other cause due to the iron.

To prevent hard spots from this cause, scrap should be carefully examined for burned iron before charging, and all suspicious looking pieces thrown out, regardless of fracture indications. It will be found more economical to consign all such iron to the dump at once than to save it for future use.

In a promiscuous lot of old scrap are to be found many pieces of wrought iron, such as bolts, nuts, stove rods, etc. This iron is totally different from cast iron, and when melted produces an iron that does not enter freely into combination with cast iron. This is more especially the case if the wrought iron has been burned or heavily coated with rust.

It is frequently claimed that these small pieces of wrought

iron can have no injurious effect upon a large body of cast iron, but they certainly do. Their effect can frequently be noticed on iron in the molten state, as it flows over the spout and drops into a ladle.

The presence of such iron is indicated, to the close observer, only for an instant, as the iron flows through the spout, by a bright shower of very small sparks, which disappear the instant the iron falls into the molten iron in the ladle.

In the ladle it may enter into combination with the cast iron, if in very small quantities. If it does not so disappear, its presence is indicated in castings by hard spots, which may occur in flanges or parts of castings to be finished, and cause the casting to be condemned.

To prevent hard spots, all such iron should be broken from the scrap and thrown out, as should also all pieces of steel, when only a soft, even iron is desired for the castings. Such iron has a higher market value than cast scrap, and it had better be sold than melted.

From an article prepared by Malcom McNaughton, of the Joseph Dixon Crucible Co., Jersey City, N. J., concerning the use of foundry facings and the quality demanded for different kinds of work, this journal condensed the following:

Molding is generally divided into four classes, to wit: Plate, green sand, dry sand and loam. This classification indicates not only the methods by which the castings are made, but serves in itself as a guide towards the selection of a suitable facing.

Plate molding is always used for light castings, and while it is within a certain sense of the word green sand molding, we have classified it by itself since it demands a different treatment in the application of facing from ordinary green sand molding.

Owing to the ornamental designs prevailing throughout plate molding, facing cannot be rubbed or brushed upon the surface of the mold without injuring the delicate lines of the design. In order to get a smooth casting the pattern is returned, or printed back, to its original position, after a coat of heavy facing, followed

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by a coat of charcoal facing, has been evenly distributed over the mold with a blacking bag.

In green sand work a facing may be applied with a camel hair brush, by hand, or dusted on with a bag, and afterwards "slicked" down. It should be noted that since the castings in this class of work are much heavier than those in plate molding, it is necessary to use a more refractory facing.

Dry sand work may be divided into two branches, skin-dried molds, in which only the surface of the mold coming in contact with the iron is dried; and dry sand molds, where the whole mold is dried by being placed in an oven or having fires built within or surrounding it. In each method different sand mixtures are used; in fact, such a variance exists in dry sand molding that but few shops pursue a similar course.

In loam molding patterns are largely done away with, and the material used for forming the mold must be one that is very flexible and readily follows the lines of the sweeps. This is very plainly seen in grooved drums and castings of a like character.

Before proceeding further let us discusus the theory upon which is based the use of foundry facings. The facing is, in the first place, put on the surface of a mold simply for the purpose of preventing adhesion of the metal to the sand of which the mold is composed. But besides the fact that it saves cleaning of the castings, it also gives them a far better appearance, and the surfaces so treated are very much easier to work in the machine shop. Wherever metal burns into the sand it causes hard spots on the castings, which quickly dull the edges of cutting tools. The reasons why graphite or plumbago facings or silver lead prevent this is as follows: Carbon is a combustible material, so that when the metal is poured into the mold, there is a sufficient amount of air in the mold itself, and also carried in by the stream of molten metal to bring about a certain amount of combustion. You may have noticed that when a drop of water falls upon a warm stove, it rolls about until it is entirely evaporated. The water itself never comes in contact with the hot surface of the stove, being separated by a film of vapor. The condition which obtains here is precisely

that which exists in the mold,—the facing begins to burn and a film of gas forms between the facing and the iron. This effectually prevents any adhesion of the metal to the sand, and just as long as this gas film exists no adhesion can possibly occur.

With regard to the difficulties to be met with in any foundry work, it is understood that a facing must burn in order to be effective, but at the same time if it burns too much, that is, gives off too much gas, we immediately get into difficulty. A proper facing will adhere perfectly to the sides of a mold, and will burn and form gas in a slow and regular manner; that is, burn just enough to furnish this little film of gas referred to above. We want to form the gas, but want to form only the least possible amount of it, and at the same time this gas must be formed during the entire time that the metal is in the fluid condition.

Another point following this is the fact that two bodies cannot occupy the same space at the same time, so that in using a cheap facing which burns fast and gives out a large amount of gas, this gas is liable to become pocketed inside of the mold, and so prevent the iron from filling the mold. This causes what are called "cold shuts" on castings. The ordinary cheap coal facings act in this way. One of the other difficulties in the use of improper facings is that of their running before the molten metal. Poor facings are not sufficiently adhesive to the sand mold surface. The hot iron, coming in contact with them, immediately dries out the sand, and if an inferior facing is in use, it will run and leave the mold surface bare. These two points alone will indicate to you why the Dixon Company make such a variety of facings. The conditions which exist in foundries are so various that it would be quite impossible even to make one facing for green sand work, and another for plate work, and that they all be equally successful in different shops. One foundry uses sand quite wet when compared with the practice in another shop. There is also a great difference in the character of the sands themselves, and there is also a great difference in the method of making the molds. In one shop the practice would be to ram the sand very much harder

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than in another shop. All these things have their bearing on the successful use of even a good facing.

F. J. Tone takes up a new softener, Carbide of Silicon, of which he writes:

This unique electrical product of "hottest heat" has come to occupy a very diversified field in the manufacturing and metallurgical world. Its original and chief use is as an abrasive, a purpose for which it is pre-eminently adapted by reason of its extreme hardness. Later its intense refractory qualities became recognized, and it gives promise of becoming a valuable material in the manufacture of fire brick, refractory linings and crucibles. In the manufacture of steel its chemical composition early brought it to the attention of metallurgists as a ready source of silicon and carbon, and it is now in special favor with the manufacturers of steel castings, among whom the consumption is very large.

The same properties which make it valuable to the steel maker make it even more valuable to the founder, and certain difficulties which were at the outset encountered in getting it into solution, have now been overcome, making the method of use very simple.

Carbide of silicon is produced in an electrical furnace from coke and sand, and contains theoretically one atom of silicon and carbon, making the proportion by weight, silicon 70 per cent and carbon 30 per cent. As manufactured by he Carborundum Company, at Niagara Falls, the commercial article contains certain impurities., An average analysis is as follows:

Silicon	62 per cent.
Carbon	35 per cent.
Iron	1.5 per cent.
Aluminum	1.5 per cent.
	100 per cent.

Calcium and magnesium are also present in minute traces. The iron and aluminum are not present in the metallic form, but like the silicon in combination with the carbon as carbides. It is

absolutely free from injurious impurities such as phosphorus and sulphur, these elements being volatilized and expelled from the furnace at a temperature far below that at which the formation of carbide of silicon begins.

The action of silicon in cast iron has been the subject of exhaustive study and investigation. Opinion is not wholly unanimous among authorities as to what extent it is the governing factor in determining the final quality of a casting; but it is well established that an increase of silicon will change combined carbon into the graphitic form, and thus give an increased softness very desirable in machine work. This action is probably most pronounced with the higher temperatures of the blast furunace, and does not always occur in marked degree at the lower temperatures at which the cupola is operated. Silicon. then, is a softener and lessener of shrinkage only by reason of its influence on carbon. These two elements together are the governing factors and their occurrence in carbide of silicon in such large proportions, constituting as they do the entire product, make it an ideal material for supplying any deficiencies which may exist in the original iron.

One of the greatest difficulties with which the founder who uses any scrap must contend is dirty castings. The cause of this is most often traced to the iron oxides which may exist in the scrap in the form of rust or burnt iron, or may be formed from prolonged heating in the cupola. Silicon is a very active deoxidizing and reducing agent, and when used with irons of the above character, it has the power of reducing a portion of these oxides to metallic iron and silica. At the same time, it unites with a certain portion to form a fluid slag of iron silicates, preventing their appearance in the casting in the form of dissolved iron oxide, dirt and spongy metal.

Carbide of silicon has been found to be especially adapted for this purpose, making available iron carrying a large burden of dirty or burnt scrap. Many founders are so situated as to transportation facilities that the use of scrap drawn from neighboring sources in place of pig transported great distances, becomes a

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matter of great economy, if not imperative necessity. As a fluxing material and softener for this class of founders, carbide of silicon is most valuable. It has been found possible to melt a charge composed entirely of burnt or small, rusty scrap, and by the judicious use of the carbide, obtain a clean flowing metal and a sharp solid casting. Without the carbide, there appeared to be more slag and dirt than iron, and it was wholly impossible to handle it.

In this case the carbide acts mainly as a reducing and fluxing agent. The metallic iron produced by the reduction of the oxides resulted in a direct gain, as was evidenced by the small amount of slag, and the fluxing action was very marked from the fluidity of the slag and the manner in which it remained free from the metal. In practice it is found that an amount of the carbide as low as one per cent of the weight of the iron in the charge will have a marked influence on the quality of the castings and behavior of the metal. This follows from its high silicon content, a very important advantage in convenience of handling and many other ways, when we consider that ferro-silicon carries only 10 to 14 per cent silicon and Scotch iron as low as 6 to 8 per cent.

The method of handling carbide of silicon in the cupola is very simple. The steel founder adds the powdered carbide in the ladle as he is tapping the furnace. The heat is very intense and the carbide becomes well intermixed under the stream of molten metal, being completely dissolved by the time the ladle is filled. This method was at first pursued in cupola practice, in fact, being still used to a very limited extent where the temperature is high. With the lower temperatures generally employed, however, which is four or five hundred degrees below that of melted steel, it is found that solution proceeds very slowly. The method most successfully employed is to charge the carbide of silicon in lump or brick form along with the pig and coke, placing the proper amount on top of each coke charge, so that as the iron melts it will come in contact with and flow over the carbide, completely absorbing the same. It has a marked effect on the fusibility of iron and fluidity of the metal in the ladle, following in this

regard the well known action of all high silicon irons, tending to make them take delicate molds well and produce clean, sharp castings.

It thus becomes apparent that carbide of silicon has a wide application in cupola practice, and with decreased cost of production it is bound to become a familiar material in every foundry.

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